

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

TIT3131 – INFORMATION THEORY

(All sections / Groups)

21 OCTOBER 2019

9.00 am – 11.00 am

(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages with **Five** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1

- (a) Classify the elements of digital communication system for 'X' and 'Y' in Table 1 with their respective output.

<i>Elements</i>	<i>Output</i>
<i>X</i>	<i>Analog symbol in waveform, suitable for transmission over the channel.</i>
<i>Y</i>	<i>Source code word.</i>

Table 1

[2 marks]

- (b) A source emits one of 28 possible symbols from the letter 'R', 'G', 'B' and 'A'.

- i. Find the value x in Table 2. Calculate the amount of information for all symbols. [5 marks]

<i>Number of characters</i>	$2x$	$3x$	$4x$	$5x$
<i>Letter</i>	'R'	'G'	'B'	'A'
<i>Probability (P_k)</i>				
<i>Amount of Information $I(s_k)$</i>				

Table 2

- ii. Refer to your answer in Table 2, write down your observation. What is the relation between the probability and the amount of information? [2 marks]
- iii. Show the information rate of this source if one of the 28 symbols is emitted, once every microsecond. [3 marks]

Continued...

QUESTION 2

- (a) Consider the following source with discrete memoryless source with source alphabet $S = \{S_0, S_1, S_2\}$ where $p_0 = x$, $p_1 = 2x$, $p_2 = 2x$. Prove that $H(S^3) = 3 H(S)$.
[4 marks]
- (b) A discrete memoryless source uses the symbols '\$', '1', '2', '3', '4', and '5' with the following probabilities.

$$P('1') = 0.08,$$

$$P('2') = 0.07,$$

$$P('3') = 0.15,$$

$$P('4') = 0.17,$$

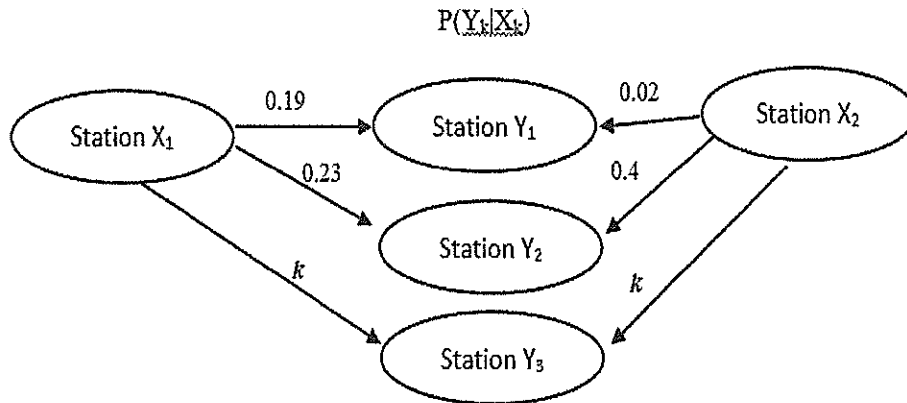
$$P('5') = 0.26,$$

$$P('$') = 0.27$$

- i) Construct a Huffman for this code. [5 marks]
- ii) Calculate the *average length* of the Huffman code and give the *redundancy* of the code. [2 marks]
- iii) Decode "01000111100000". [1 mark]

QUESTION 3

- (a) A source X produces letters from a two symbol alphabet with the probability assignment $P_x(0) = 0.5$ and $P_x(1) = 0.5$. Each source letter X is transmitted through a channel from a source X to the destination Y as shown in **Figure 1**. The transition probabilities are indicated as below.

**Figure 1**

- i. From **Figure 1**, what is the value of k ? Prepare the conditional probability $P(y|x)$ and joint probability tables $P(y,x)$. [5 marks]
 - ii. Write all the steps to show that $I(Y,X)$ equal to $I(X,Y)$. [5 marks]
- (b) Explain whether code I and code II in **Table 3** are uniquely decodable using Kraft inequality. [2 marks]

Symbols	Code I	Code II
S_0	1	0
S_1	00	110
S_2	001	100
S_3	011	111

Table 3

QUESTION 4

(a) What is **systematic** and **non-systematic** codes? [2 marks]

(b) Identify whether the following statements in **Table 4** is **TRUE/FALSE**. [2 marks]

Property	Statements	TRUE/FALSE
Linearity property	A cyclic code is not a linear block code	
Cyclic property	The sum of two code words is also a code word.	

Table 4

(c) Construct the generator matrix, $g(D) = 1 + D + D^2 + D^4$ in "**systematic**" form. [3 marks]

(d) Construct all the valid code words for the following messages in "**non-systematic**" form. Show your steps.

Message	$m(D)$	$c(D)$	Code word
1110		$1 + D^2 + D^4$	
1101		$1 + D$	

[2 marks]

(e) Consider the generator polynomial for a (8, 4) cyclic code generated by $g(D) = 1 + D + D^3 + D^4$. Construct the valid code words for the following messages in "**systematic**" form. Show your steps.

Message	$m(D)$	$c(D)$	Code word
0100			
1100			
1111			

[3 marks]

QUESTION 5

- (a) Construct the encoder circuit for the generator polynomial for a (7, 4) cyclic code generated by $g(D) = 1 + D + D^3$.

[4 marks]

- (b) Construct a state diagram for a convolutional path $g_1[1,1,1]$ and $g_2[1,1,0]$ from Table 5.

m_0 Input	m_1	m_2	g_1	g_2	Current State	Next State
0	0	0	0	0	00	00
1	0	0	1	1	00	10
0	1	0	1	1	10	01
1	1	0	0	0	10	11
0	0	1	1	0	01	00
1	0	1	0	1	01	10
0	1	1	0	1	11	01
1	1	1	1	0	11	11

Table 5

[4 marks]

- (c) Trace the path of the code tree in Figure 2 corresponds to the message sequence 1010, 1011, 1100 and 1110. (Note: The message is input from right to left)

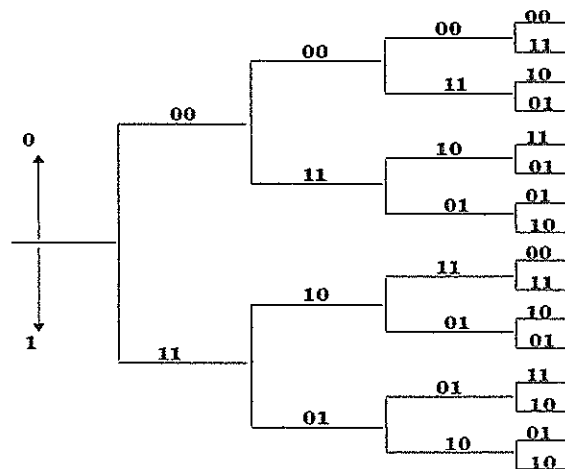


Figure 2

[4 marks]

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